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APPLICATION

FOR

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TITLE: SCRUBBING BRUSH WITH LIGAND ATTACHMENTS

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SCRUBBING BRUSH WITH LIGAND ATTACHMENTS

Background

This invention relates generally to brushes that may be utilized for scrubbing and/or cleaning semiconductor wafers.

During semiconductor integrated circuit fabrication, a wafer may be subjected to a variety of different processes that may necessitate subsequent cleaning. For example, after chemical mechanical polishing, it is common to clean the wafers. In this regard, the wafers may be placed between counter-rotating brushes which scrub the wafers clean. At the same time, chemical cleaning solutions may be sprayed at the interface between the wafer and the brushes.

If the wafers are not adequately cleaned, defects may occur. Each wafer may include a large number of die which ultimately become integrated circuits.

Thus, it is desirable to reduce the defects in semiconductor wafers by providing better cleaning.

Brief Description of the Drawings

Figure 1 is a schematic depiction of one embodiment of the present invention; and

Figure 2 is a schematic depiction of a chemical process in accordance with one embodiment of the present invention.

Detailed Description

Referring to Figure 1, a semiconductor wafer W may be cleaned by counter-rotating brushes 10a and 10b. Conventionally, the brushes 10 have a central axle 12a or 12b. Polymer bristles are attached to the central axle 12 to provide a scrubbing cleaning of the intervening wafer when the brushes 10 are counter-rotated. At the same time, chemical cleaning solution may be supplied from dispensers 14a and 14b at the brush/wafer interface. Cleaning solutions may also flow through the brushes 10 from their interiors.

Conventionally the brushes 10 may be made of polyvinyl alcohol. Most commonly, the brushes are formed of formal polyvinyl alcohol which has a methyl group which bridges between two spaced carbon groups along the polyvinyl alcohol chain.

Referring to Figure 2, the polyvinyl alcohol chain 18 may have a repeating chain structure of the type indicated, including a plurality of carbon groups coupled one to the other to form a polymer. A moiety or moieties 16 may be coupled between two carbon atoms spaced by an intervening carbon atom. The moiety or moieties 16 may be coupled to the chain through oxygen molecules as illustrated. In

formal polyvinyl alcohol, the moiety 16 is a methyl group. In conventional or non-formal polyvinyl alcohol, each oxygen atom is coupled to two separate hydrogen atoms that form the structure shown in the box 16. In such a structure, each unit of polyvinyl alcohol may include three hydroxyl groups, a hydroxyl group being coupled to every other carbon along the chain 18.

In order to improve the cleaning efficacy of the brushes 10, using conventional or formal polyvinyl alcohol, to mention two examples, a coupling agent 20 may be utilized. In one embodiment, the coupling agent 20 may be silane. The coupling agent 20 couples to one or more of the hydroxyl groups along the length of the polyvinyl alcohol chain 18. It may do so using a hydrolysis reaction giving up H_2O as indicated. However, the coupling agent 20 may be any entity which is capable of enabling the attachment of a ligand 24 to the length of the polyvinyl alcohol chain 18. The ligand 24 then generally extends away from the length of the modified interface 22 and provides its own separate cleaning element. This element acts as, in effect, a separate bristle extending from the length of the polyvinyl alcohol chain 18.

The number of such ligands 24 that may be attached is subject to considerable variability. In addition, the ligand 24, shown in Figure 2, may have a subchain 26, indicated as $(CH_2)_n$. The length of the subchain 26 may be

subject to considerable variability. For example, subchains 26 as short as two methyl groups may be possible and subchains as long as 40 methyl groups or longer may be feasible. The longer the subchain 26 of the methyl groups, the longer the extension of the attaching ligand 24 from the main chain 18. The longer its extension, the greater its effectiveness of the subchain 26 in acting as a relatively thin fiber to get into nooks and crannies on the wafer to be cleaned and to effectively clean small spaces.

Also attached to the ligand 24 is a moiety indicated as X. In one embodiment, the moiety X may include a functional species that may render the attaching ligand 24 hydrophobic, for example, if X is a hydrocarbon, such as methyl group. Conversely, if the moiety X is an ammonia group compound, it may render the ligand 24 hydrophilic. The moiety X may also be a functional species that enables the ligand 24 to act as an oxidizer, such as phosphate, or a reducing agent, such as nitrate. Alternatively, the X moiety may attract the ligand 24 to specific things that need to be cleaned on the semiconductor wafer. For example, if it is a copper surface that needs particular attention, a moiety X, such as benzotriazole that is attracted to copper may be utilized.

Thus, in accordance with some embodiments of the present invention, a chemical ligand 24 may be attached to a polymer chain 18 to provide specific cleaning functions,

as well as enhanced mechanical functions due to the use of an effective microfiber that extends away from the interface 22. The ligand 24 may be formed by reacting a coupling agent 20 to the alcohol groups on the brush chain 18 in one embodiment. The ligand 24 may dangle from the brush interface and disrupt and/or reduce the boundary layer at the water surface, resulting in increased cleaning efficiency.

The ligand 24 can also serve to change the surface charge (zeta potential) of the brush 10. Thus, the user can engineer specific positive or negative zeta potentials of the brushes 10 by adding moieties X of specific charge, such as carboxylic acids, amines, or nitrates.

In some embodiments, a variety of characteristics of the ligand 24 may be altered. The length of the ligand may be altered in one embodiment. The nature of the moiety X may be altered. The surface charge may be altered in another embodiment. The extent of brush surface conversion to the ligands may be altered in some embodiments.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is: